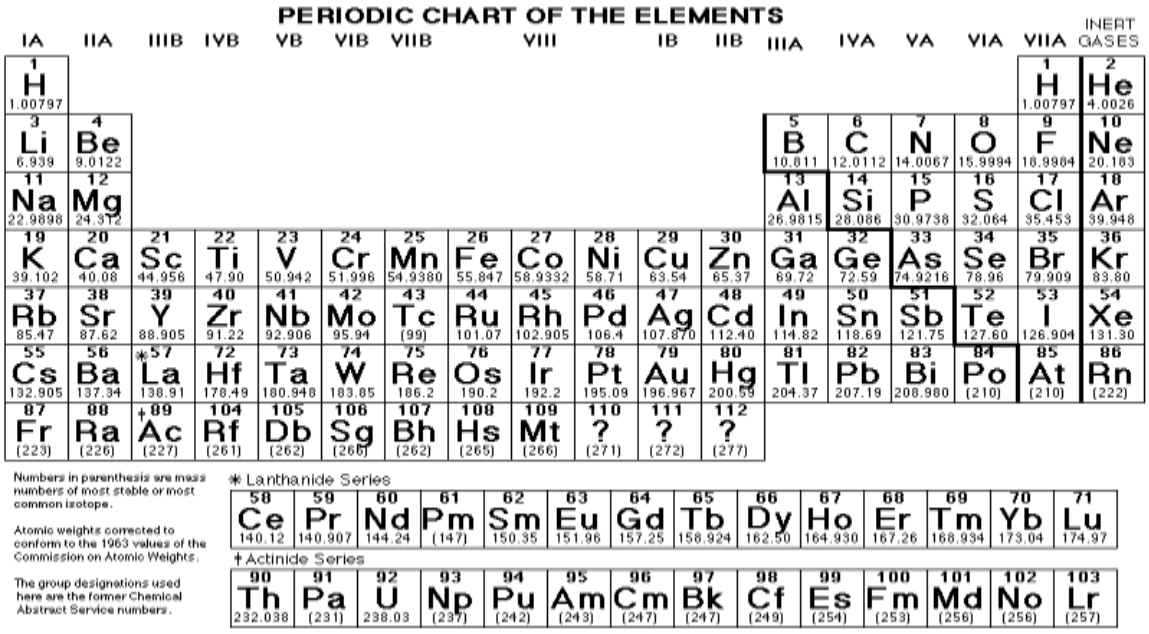
2nd Semester Review Practice Problems
Chem Pre-AP

You will need to complete the following practice problems. Please use your book, notes, and the following formulas to work through them. These problems cover the **CONCEPTS** that you will see on the final **NOT** the exact wording or direction of the questions on the final. The following periodic table, formulas, and Standard Reduction Potential Table will be provided to you on the final. Use more paper as needed.



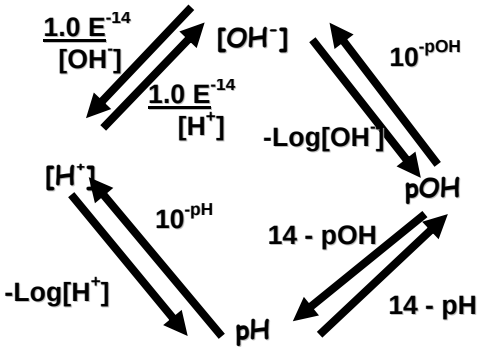
Calorimetry

1 Cal = 1000 cal = 1 kcal = 4.184 kJ

$q = (m)(C_p)(\Delta T)$

$C_p\ H_2O = 4.184 J/g°C$

Acid Base Chemistry



$HA \leftrightarrow H^+ + A^-$

$$k_a = \frac{[H^+][A^-]}{[HA]}$$

$XOH \leftrightarrow X^+ + OH^-$

$$k_b = \frac{[OH^-][B^{\mp}]}{[BOH]}$$

$M_aV_a=M_bV_b$

Gas Laws

Grams/ Vol A → Moles A → Moles B → Grams/ Vol B

$P_1V_1=P_2V_2$, $\frac{P_1V_1}{T_1}=\frac{P_2V_2}{T_2}$, $\frac{V_1}{T_1}=\frac{V_2}{T_2}$, $PV=nRT$, $d=\frac{PM}{RT}$

$R = 0.0821\ \frac{L\cdot atm}{mol\ K}$

1atm = 760 mmHg =760 torr = 101.325 kPa

STP = 0°C and 1 atm

Electrochemistry

Acidic solution:

1. Assign oxidation numbers to determine what is oxidized and what is reduced, if no change in oxidation numbers occurs it is not a redox reaction and you must balance by inspection.
2. Write the oxidation and reduction half-reactions.
3. Balance each half-reaction.
   a. Balance elements other than H and O.
   b. Balance O by adding H_2O.
   c. Balance H by adding H^+.
   d. Balance charge by adding electrons.
4. Multiply the half-rxn by integers so that the e^- gained and lost are the same.
5. Add the half-reactions, subtracting things that appear on both sides.
6. Make sure the equation is balanced according to mass and to charge.

In a **Basic Solution**: Once the equation is balanced, add OH^- to each side to "neutralize" the H^+ in the equation and create water in its place. $H^+ + OH^- \rightarrow H_2O$ If this produces water on both sides, you might have to subtract water from each side.

Standard Potential (V)	Reduction Half-Reaction
2.87	$F_2(g) + 2e^- \longrightarrow 2F^-(aq)$
1.51	$MnO_4^-(aq) + 8H^+(aq) + 5e^- \longrightarrow Mn^{2+}(aq) + 4H_2O(l)$
1.36	$Cl_2(g) + 2e^- \longrightarrow 2Cl^-(aq)$
1.33	$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^- \longrightarrow 2Cr^{3+}(aq) + 7H_2O(l)$
1.23	$O_2(g) + 4H^+(aq) + 4e^- \longrightarrow 2H_2O(l)$
1.06	$Br_2(l) + 2e^- \longrightarrow 2Br^-(aq)$
0.96	$NO_3^-(aq) + 4H^+(aq) + 3e^- \longrightarrow NO(g) + H_2O(l)$
0.80	$Ag^+(aq) + e^- \longrightarrow Ag(s)$
0.77	$Fe^{3+}(aq) + e^- \longrightarrow Fe^{2+}(aq)$
0.68	$O_2(g) + 2H^+(aq) + 2e^- \longrightarrow H_2O_2(aq)$
0.59	$MnO_4^-(aq) + 2H_2O(l) + 3e^- \longrightarrow MnO_2(s) + 4OH^-(aq)$
0.54	$I_2(s) + 2e^- \longrightarrow 2I^-(aq)$
0.40	$O_2(g) + 2H_2O(l) + 4e^- \longrightarrow 4OH^-(aq)$
0.34	$Cu^{2+}(aq) + 2e^- \longrightarrow Cu(s)$
0	$2H^+(aq) + 2e^- \longrightarrow H_2(g)$
−0.28	$Ni^{2+}(aq) + 2e^- \longrightarrow Ni(s)$
−0.44	$Fe^{2+}(aq) + 2e^- \longrightarrow Fe(s)$
−0.76	$Zn^{2+}(aq) + 2e^- \longrightarrow Zn(s)$
−0.83	$2H_2O(l) + 2e^- \longrightarrow H_2(g) + 2OH^-(aq)$
−1.66	$Al^{3+}(aq) + 3e^- \longrightarrow Al(s)$
−2.71	$Na^+(aq) + e^- \longrightarrow Na(s)$
−3.05	$Li^+(aq) + e^- \longrightarrow Li(s)$

Nuclear Chemistry

Half Life formula

$\frac{0.693}{k} = t_{1/2}$ $\quad ln\frac{N_o}{N_t} = kt$

Practice Problems:

Stiochiometry

- **Mole A to Mole B and Gram A to Gram B**
  - **Mole Bridge**
- **Limiting reagents**

1. What is stiochiometry?

2. How is the Mole Bridge formulated?

3. What amount of moles of H_2 gas is formed form the rxn of 10g of Zn and excess HCl, if only Zinc (II) Chloride and hydrogen gas are formed?

4. Based on the previous problem how many grams of hydrogen gas is formed in the 10g Zn is reacted with 10g HCl?

Molecualr geometry

- **Lewis Structure**
  - **Total Valance Electrons**
  - **Resonance Structures**
- **Shapes**
  - **Bonding vs non bonding regions**
  - **Linear, Bent, Triginal Planer, Triginal Pyramidal, Tetrahedral**

1. What are the steps for drawing Lewis structures?

2. What are the lewis structures of CH_4 and PH_3?

3. How do the different molecular geometries differ from each other?

4. If there are four bonds what molecular geometry does a compound have? (CH_4) What about three bonds and one lone pair? (CH_3)

Gas laws

- **Pressure and conversions**
- **Kelvin**
- **Boyles**
- **Charles**
- **Avogadro's**
- **Combined**
- **Ideal**
  - **Gas constant**
  - **Density/ Molar mass**

1. How many kPa are equivalent to 2.5atm?

2. A 0.500 L flask containing helium gas at 740 mmHg is connected to a system under vacuum and allowed to expand into the system. The final pressure observed is 222 mmHg. What is the volume of the system (L)?

3. A 50.0-mL container has a gas at a pressure of 645 atm and a temperature of 25^{o}C. The entire sample is heated to a temperature of 35^{o}C and transferred to a new container whose volume is 65.0 mL. What is the pressure (atm) of the gas in the second container?

4. A 725 gram sample of neon is introduced into a 4.5 L cylinder which is then heated until the pressure is 225 atm. What is the temperature (^{o}C) of the gas?

5. An incandescent light bulb with a volume of 125 cm^3 contains 2.5 x 10^{-3} moles of argon. What is the pressure of argon (atm) at 25^{o}C?

6. When 1mol of O_2 gas is combusted with hydrogen according to the unbalanced equation below, how many L of H_2O are produced at STP? (Use stoichiometry first!)

$$O_2 + H_2 \rightarrow H_2O$$

7. What volume of hydrogen gas is produced at 335K and 1.2atm, if 5g of Mg is reacted with excess HCl producing only $MgCl_2$ and H_2 gas?

8. What is the density of the hydrogen gas in the previous problems?

Solutions

- **Concentrations**
  - **Molarity**
  - **Molality**
  - **% mass/volume (g/100mL)**
- **Dilutions**
- **Making solutions**
- **Precipitation**
- **Net ionic equations**

1. What are the formulas for determining Molarity and Molality?

2. What is the molarity of 2.3g of KOH dissolved in water to a volume of 450mL?

3. What volume of 11M HNO_3 should be used to prepare 250mL of 0.8M HNO_3?

4. A student wishes to prepare approximately 100 milliliters of an aqueous solution of 6M HCl using 12 M HCl. Which procedure is correct?

adding 50 mL of 12M HCl to 50 mL of water while stirring the mixture steadily.
adding 50 mL of 12M HCl to 50 mL of water & then stirring the mixture steadily.
adding 50 mL of water to 50 mL of 12M HCl while stirring the mixture steadily.
adding 50 mL of water to 50 mL of 12M HCl & then stirring the mixture steadily.

5. What, if any, would be the precipitate of the mixing a solution of $Ba(OH)_2$ with $Pb(NO_3)_2$?

6. What is the net ionic equation of the previos questions ($Ba(OH)_2$ with $Pb(NO_3)_2$)?

Acid Base

- **Definitions**
- **Nomenclature**
- **Strong Acid/ Base**
- **pH → $[H^+]$ → $[OH^-]$ → pOH**
- **Titrations**
- **Weak Acid/ Base**
  - **K_a/K_b**
  - **ICE tables**

1. What is an Arrhenius acid?

2. Name the following acids/bases.
Which substance can be classified as strong acid? Why?

H_2SO_3 **KCl** **LiOH** **H_2SO_4**

3. What is the pH of a $1.0x10^{-5}$ molar HCl solution? $[OH^-]$?

4. Which 0.1 M solution will turn phenolphthalein pink?

HBr(aq) **CO_2(aq)** **LiOH(aq)** **CH_3OH(aq)**

5. The following data were collected at the endpoint of a titration performed to find the molarity of an HCl solution.

Volume of acid (HCl) used = 14.4 mL
Volume of base (NaOH) used = 22.4 mL
Molarity of standard base (NaOH) = 0.20 M

What is the molarity of the acid solution?

6. Label the acid, base, conjugate base, and conjugate acid in the reactions below:

a.) $HCN + H_2O \leftrightarrow CN^- + H_3O^+$

b.) $H_2O + HNO_3 \leftrightarrow H_3O^+ + NO_3^-$

c.) $CO_3^{2-} + H_2SO_4 \rightarrow HCO_3^- + HSO_4^-$

7. Write the K_a or K_b for the reactions of the following acids or bases with water:

a.)$CH_3CH_2NH_2 + H_2O \rightarrow CH_3CH_2NH_3^+ + OH^-$

b.) $HN_3 + H_2O \rightarrow H_3O^+ + N_3^-$

c.) $N_2H_4 + H_2O \rightarrow N_2H_5^+ + OH^-$

8. What is the pH of a 1.5M solution of nitrous acid, $K_a = 4.0x10^{-4}$? (write the Ka expression first).

9. What is the pH of a 0.5M of NH_3 ($k_b = 1.8 \times 10^{-5}$) (use an ICE table)

Redox and Electrochem

Oxidation number

½ Rxn Balancing method

Galvonic cell

Cell potential; E_{cell}

1. What is a redox Reaction?

2. Indicate the oxidation number for each element in the following compounds:

a. $MgSO_4$
b. Al_2O_3
c. $NaNO_3$
d. $KClO_3$
e. $KClO_4$
f. $Mg_3(PO_4)_2$
g. $Al(NO_3)_3$

3. Determine which of the following are Redox rxns, and if it is a redox; 1 determine what is being reduced/ oxidized AND balance it using ½ rxn method..

a. $Na + Cl_2 \rightarrow NaCl$
b. $C + O_2 \rightarrow CO_2$
c. $H_2O \rightarrow H_2 + O_2$
d. $NaCl + AgNO_3 \rightarrow AgCl + NaNO_3$
e. $KClO_3 \rightarrow KCl + O_2$
f. $H_2SO_4 + KOH \rightarrow K_2SO_4 + H_2O$

4. Using a standard reduction potential table calculate the following E°_{cell}. Some of the potentials may be negative.

a. $Cu(s) + 2\ Ag^+(aq) \rightarrow Cu^{2+}(aq) + 2\ Ag(s)$
b. $2\ Fe^{3+}(aq) + 2\ Cl^-(aq) \rightarrow 2\ Fe^{2+}(aq) + Cl_2(g)$
c. $2\ Fe^{3+}(aq) + 2\ I^-(aq) \rightarrow 2\ Fe^{2+}(aq) + I_2(aq)$
d. $2\ H_2O_2(aq) \rightarrow 2\ H_2O(l) + O_2(aq)$
e. $Cu(s) + 2\ H^+(aq) \rightarrow Cu^{2+}(aq) + H_2(g)$

5. Looking at the previous question for a, b, and c; identify the anode and cathode

Thermochemistry

1st law Thermodynamic

Calorimetry

Hess's law

1. State the three (3) part of the 1st Law of Thermodynamics:

2. If a 10ml sample of water at 10°C rises to 25°C what is the heat value?

3. 135 g of Au (initially at 400°C) are mixed with an unknown mass of water (initially at 25°C). When thermal equilibrium is reached, the system has a temperature of 80°C. Find the mass of the water.

4. Calculate the value of $\Delta H°$ for the reaction below using the following enthalpy values.

$$2\ N_2\ (g)\ +\ 5\ O_2\ (g)\ \rightarrow\ 2\ N_2O_5\ (g).$$

$H_2\ (g)\ +\ ½\ O_2\ (g) \rightarrow\ H_2O\ (l)$	$\Delta H° = -285.8$ kJ
$N_2O_5\ (g)\ +\ H_2O\ (l)\ \rightarrow\ 2\ HNO_3\ (l)$	$\Delta H° = -76.6$ kJ
$½\ N_2\ (g)\ +\ {}^3/_2\ O_2\ (g) +\ ½\ H_2\ (g) \rightarrow HNO_3\ (l)$	$\Delta H° = -174.1$ kJ

5. If the heat of combustion for butane is 2877kJ/mol what is the heat produced from 15g of butane (MM 58 g/mol)?

Nuclear Chemistry ?????? No sure if we will get to this but if not = not on Final

Nuclear decay / rxn

Beta, alpha, gamma, etc.

Half life

1. What is a beta particle? Alfa particle?

2. Complete the following decay: ${}^{175}_{93}Np \rightarrow\ {}^{4}_{2}He +\ {}^{A}_{Z}X$

3. If 100.0 g of carbon-14 decays until only 25.0 g of carbon is left after 11 460 years, what is the half-life of carbon-14?

4. Thallium-208 has a half-life of 3.053 min. How long will it take for 120.0g to decay to 7.50 g?